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THE SECOND PHASE OF THE ITALIAN PROGRAM FOR RESEARCH WITH THE AID OF SOUNDING ROCKETS

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The second phase of the Italian upper atmosphere research program using rocket probes began last April with three consecutive launchings from the Perdasdefogu Interservice Range. The experimental technique here involved sodium and lithium clouds, similar to the January launching.

The launch series was conducted with a view to two basic purposes. On the one hand, we wanted to study the "short-period" fluctuations in the dynamics and structure of the upper atmosphere above the missile range. For this purpose, the launchings were made consecutively, i.e., the first in the evening of 19 April (sunset); the second in the morning of the 20th (dawn); and the third, at sunset of the same day.

The other problem we wanted to investigate was the "global dynamics" of the atmosphere, i.e., we wanted to get more information on the circulation of air at high altitudes, all around the globe. To that end, an agreement was concluded with NASA on simultaneous launchings (except for local time differences) from the missile ranges at Perdasdefogu and Wallops Island (US).

In both cases, these were the first experiments of this kind with rocket probes. The excellent success of the launchings, both in Italy and in the US, will furnish us with useful information on the principal problems of the upper atmosphere.

The Nike-Asp rocket combination was used in all three cases. The Asp, which is the second stage, is still an experimental rocket, but its high performance made it preferable to other, proved rockets. The use of the Nike-Asp made it possible to get data between the altitudes of 80 and 200 km; thus we covered one of the most interesting zones of the upper atmosphere.

As I said before, the launchings were completely successful. In particular, the land-based photographing stations, located in the same positions as last January, were able to take good pictures despite not entirely favorable meteorological conditions; they collected a vast amount of information.

The data were processed with the methods described for the January launching. As soon as the true position of each point of the cloud in space had been established for predetermined moments, we proceeded to calculate the dynamic and structural characteristics of the atmosphere.

This memorandum pertains to the results relative to the dynamic part, i.e., the intensity and direction of the winds during the first two launchings. On the basis of the customary assumptions on the behavior of high-altitude winds, the latter were plotted from the cloud's

projection onto the horizontal plane at successive instants in time. By way of example, we might look at figures 1 and 2, containing diagrams for the first and second launchings of the April series; here we find the position of the central axis of the cloud at two successive instants (for reasons of greater simplicity, the figures show only two curves).

Figure 3 gives the polar diagram of the winds for the evening of 19 April between the altitudes of 83 and 200 km. We should note particularly the double "shear" at the lower altitudes, i.e., between 83 and 95 km. As we go higher up, we no longer get any shear, but a gradual rotation in a clockwise direction for three quadrants up to 125 km /altitude/. Then the wind -- whose direction is ENE at 125 km -- tends to move in a counterclockwise direction until it becomes stabilized in a southern direction at 150 km.

The wind intensity, which had earlier reached a relative maximum around 105 km, then tends to increase, starting at 135 km, until it reaches the absolute maximum of 140 m/sec at 180 km altitude. From 153 km to 200 km, the wind maintains its direction, except for a minor change at about 180 km altitude, which must be related to the maximum intensity reached there. Figures 4 and 5 give the projection of the winds on the vertical east-west and north-south planes for the launcher.

Figures 6 to 8 refer to the second launch, repeating the scheme adopted in figures 3 to 5 for the first launch. The first indications refer to the altitude of 108 km, and hence we do not have a shear here. We can easily recognize a regular rotation here in a clockwise direction, similar to the one found in the first launching, but not as protected. From the altitude of 125 km (note the similarity to the first launch), the wind assumes a stable direction, while its intensity increases to a maximum of 135 m/sec, which is practically equal to that of the first launch, at altitudes from 170 to 190 km. In contrast to the first launching the variations in directions at the higher altitudes are sufficiently noticeable.

For the second launching, we have data also for a portion of the descending trajectory between 190 and 140 km altitude; from this we get the indications on the "very short period" fluctuations, i.e., on the direction and intensity of the winds which are very few minutes apart in the same zone. This situation is shown in Figure 9. Logically, the two curves are very similar, but we can detect a certain difference, both as to intensity and as to direction, which becomes more noticeable rather gradually, as the altitude decreases while the time difference between the two curves increases.

FIGURE APPENDIX

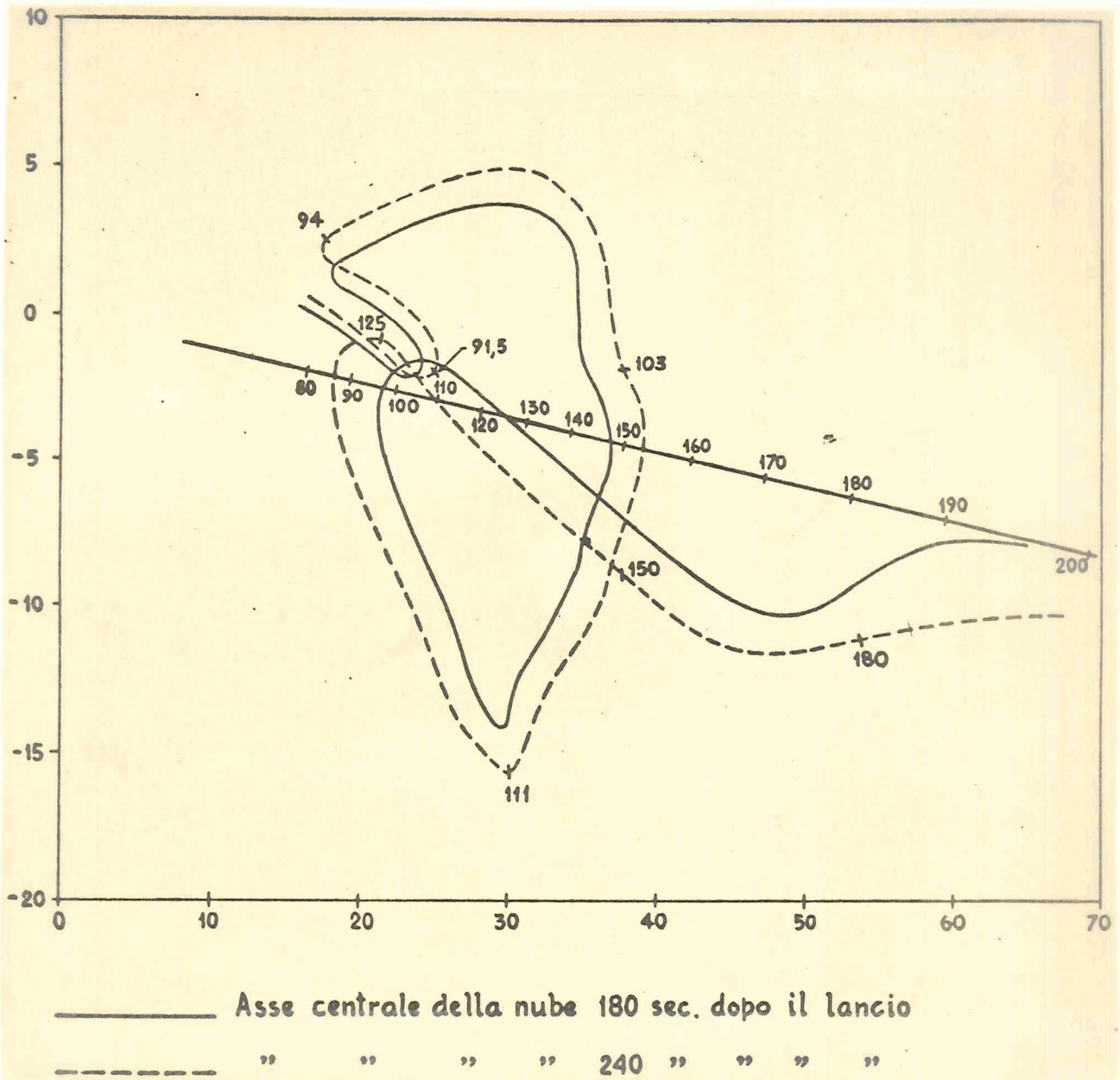

Figure 1. Horizontal projection of cloud. _____ Central axis of cloud 180 sec after launch; _ _ _ central axis of cloud 240 sec after launch.

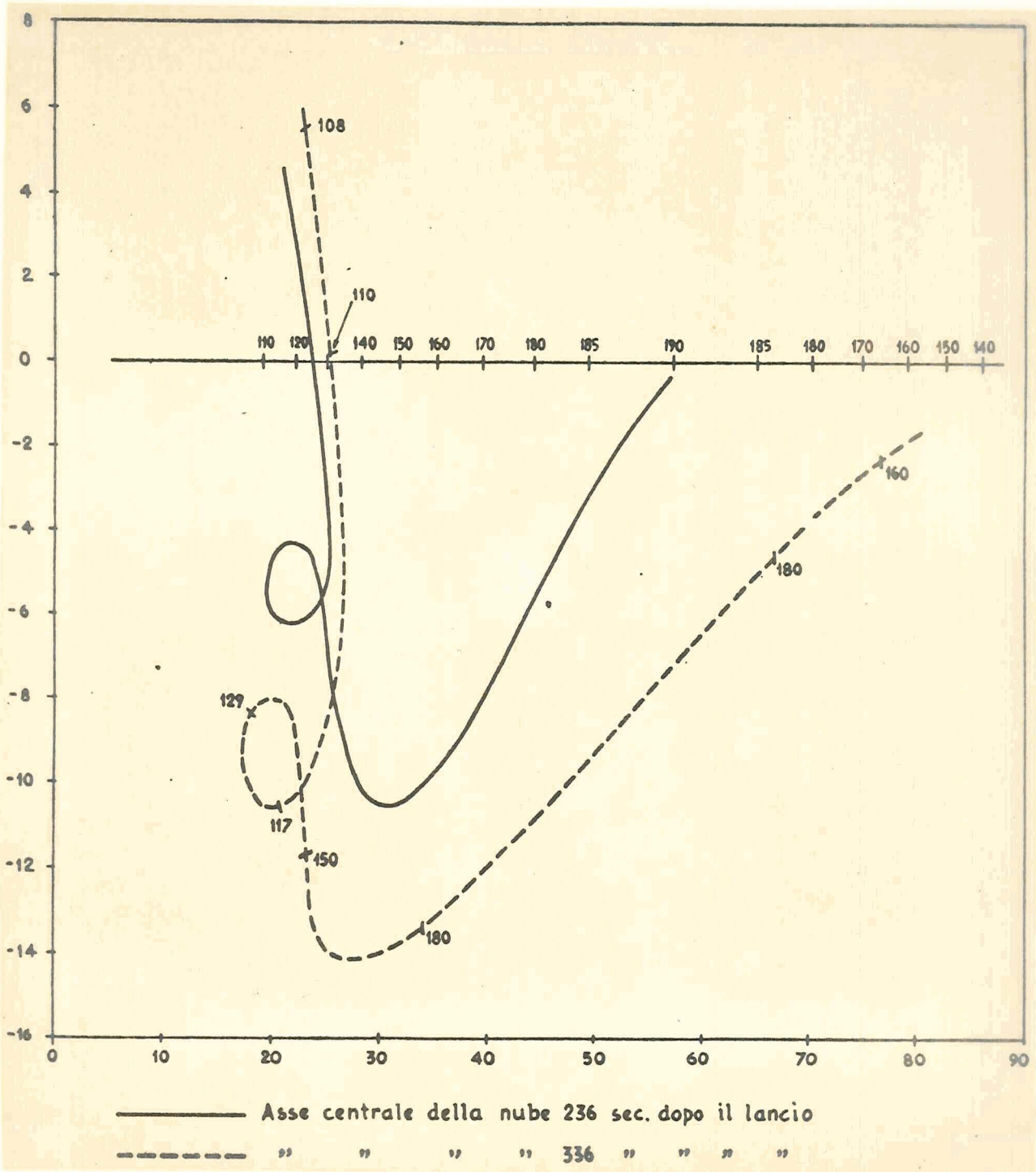

Figure 2. Horizontal projection of cloud. _____ Central axis of cloud 236 sec after launch; _ _ _ central axis of cloud 336 sec after launch.

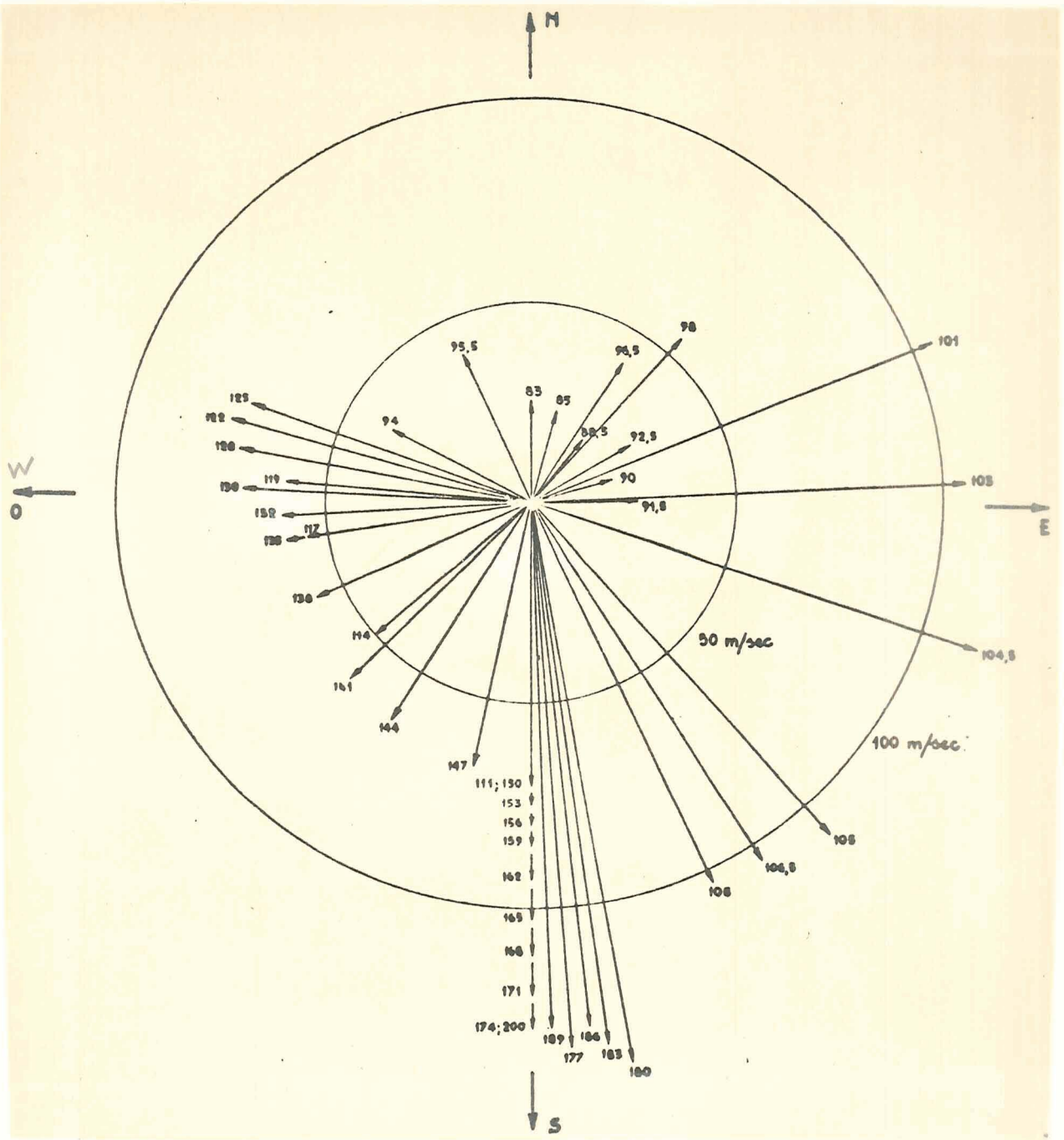

Figure 3. First Launch, sunset, 19 April 1961. Polar diagram of wind intensity and direction, speed in m/sec, altitudes in km.

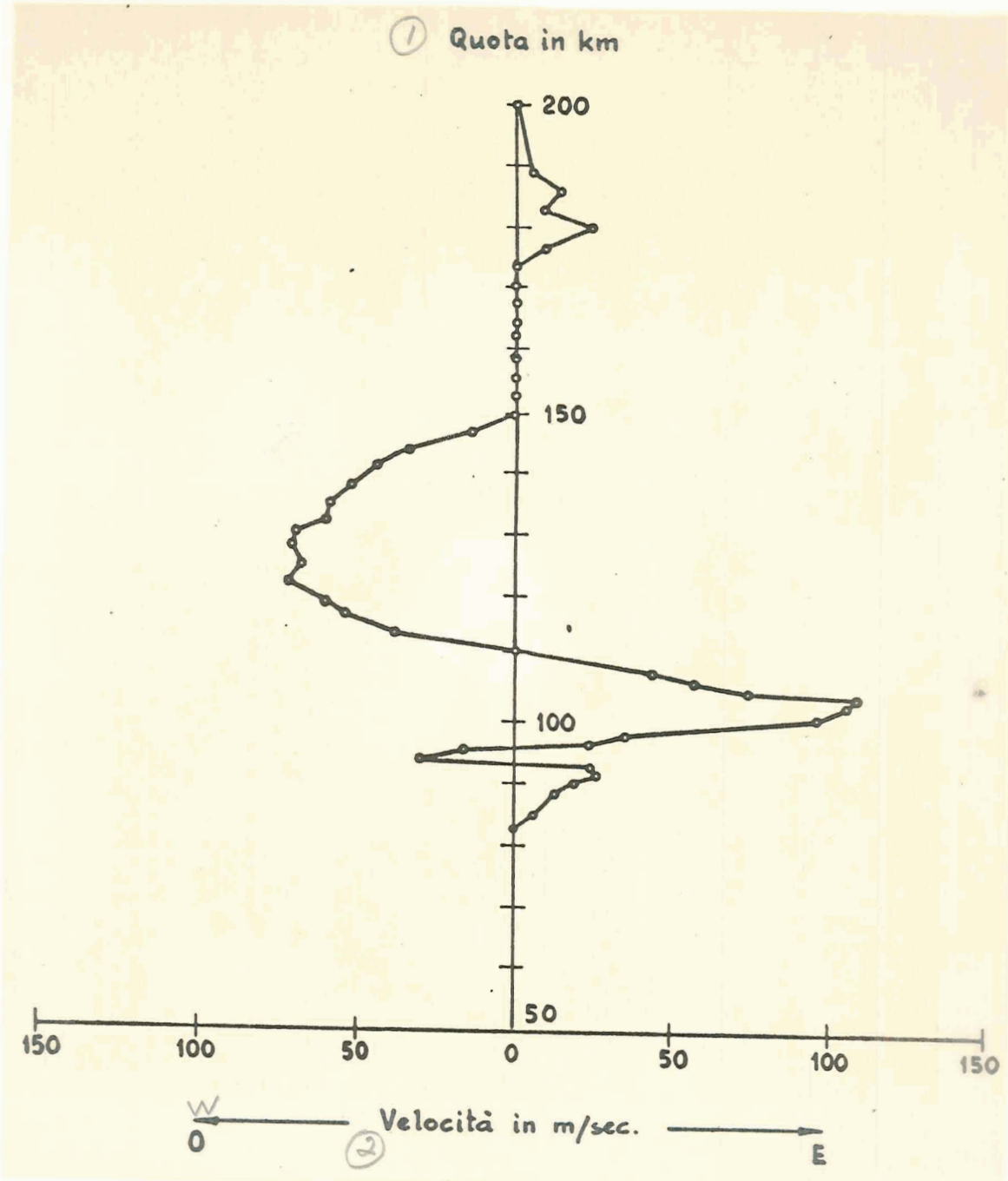

Figure 4. First Launch, sunset, 19 April 1961. 1 -- alt in km; 2 -- speed in m/sec.

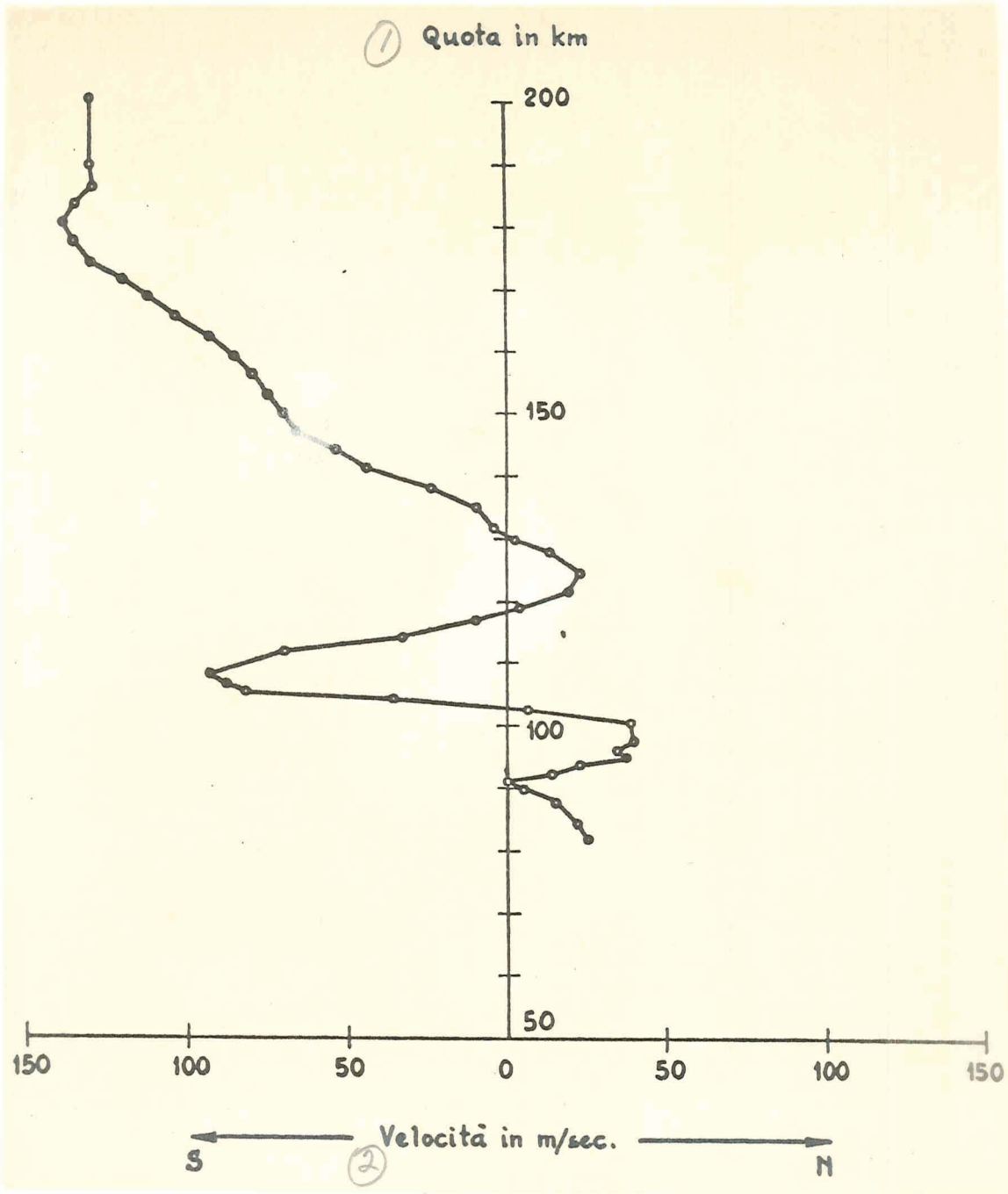

Figure 5. First Launch, sunset, 19 April 1961. 1 -- alt in km; 2 -- speed in m/sec.

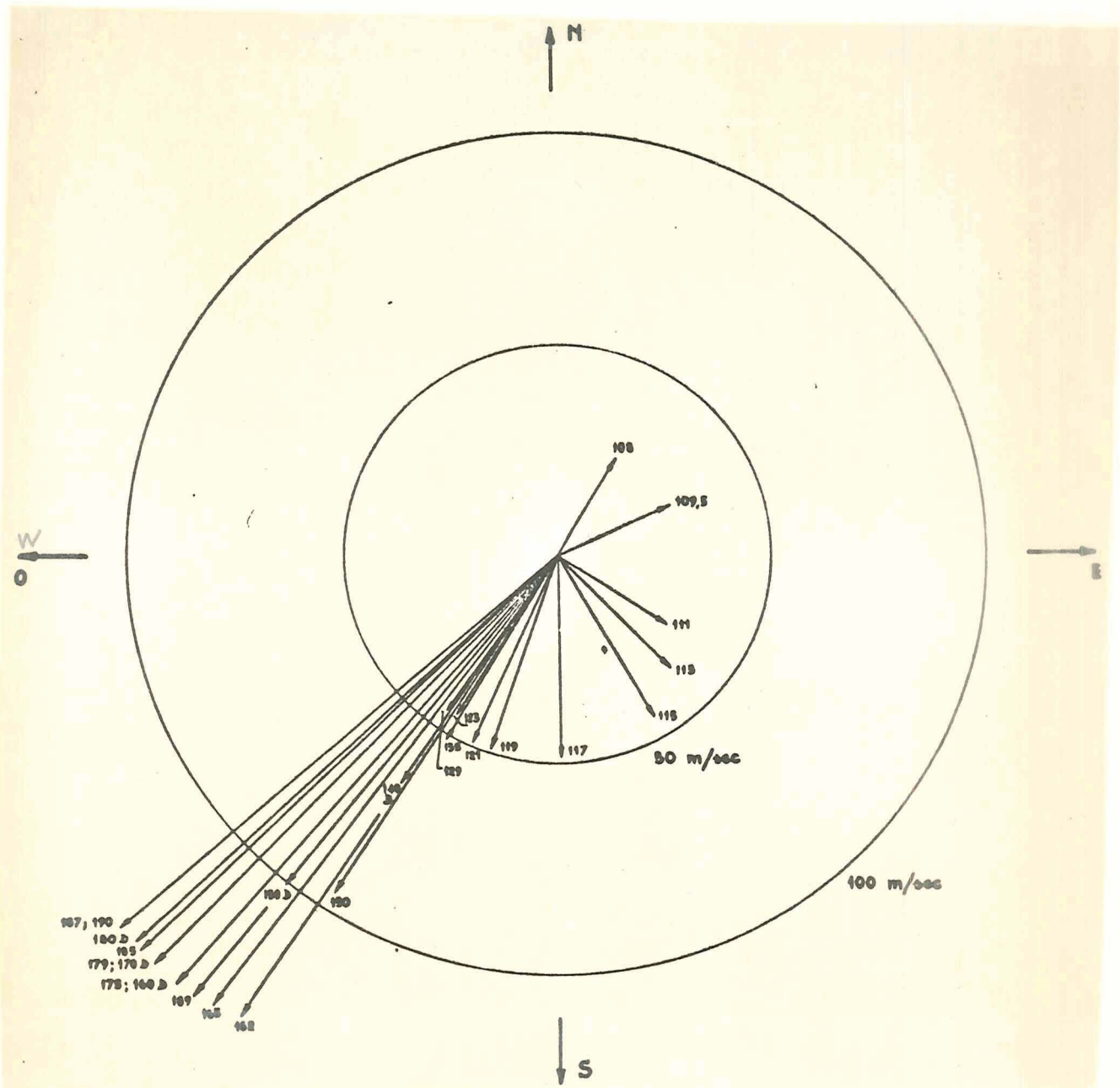

Figure 6. Second Launch, dawn, 20 April 1961. Polar diagram of wind intensity and direction, speed in m/sec, altitudes in km.

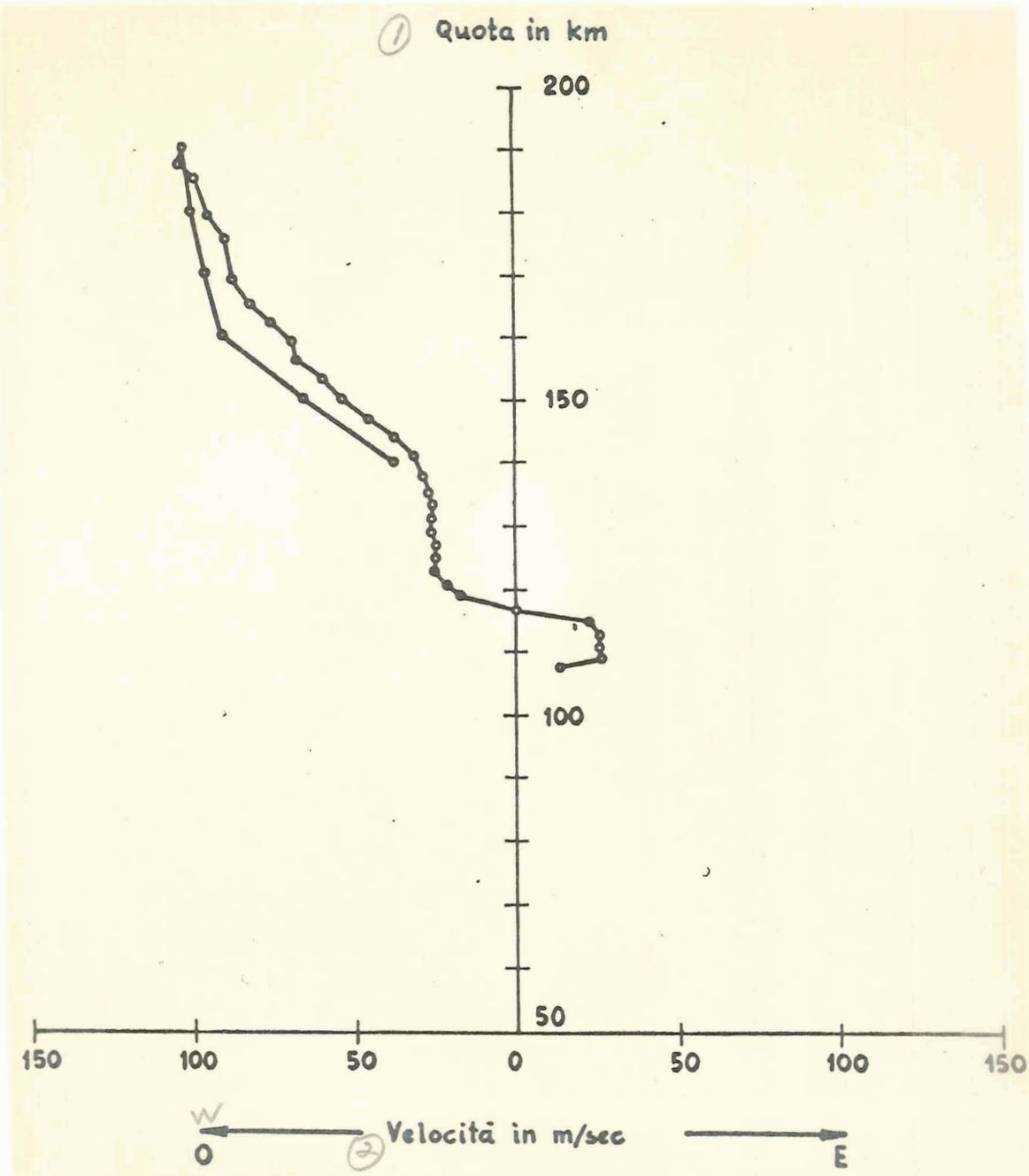

Figure 7. Second Launch, dawn, 20 April 1961. 1 -- alt in km; 2 -- speed in m/sec.

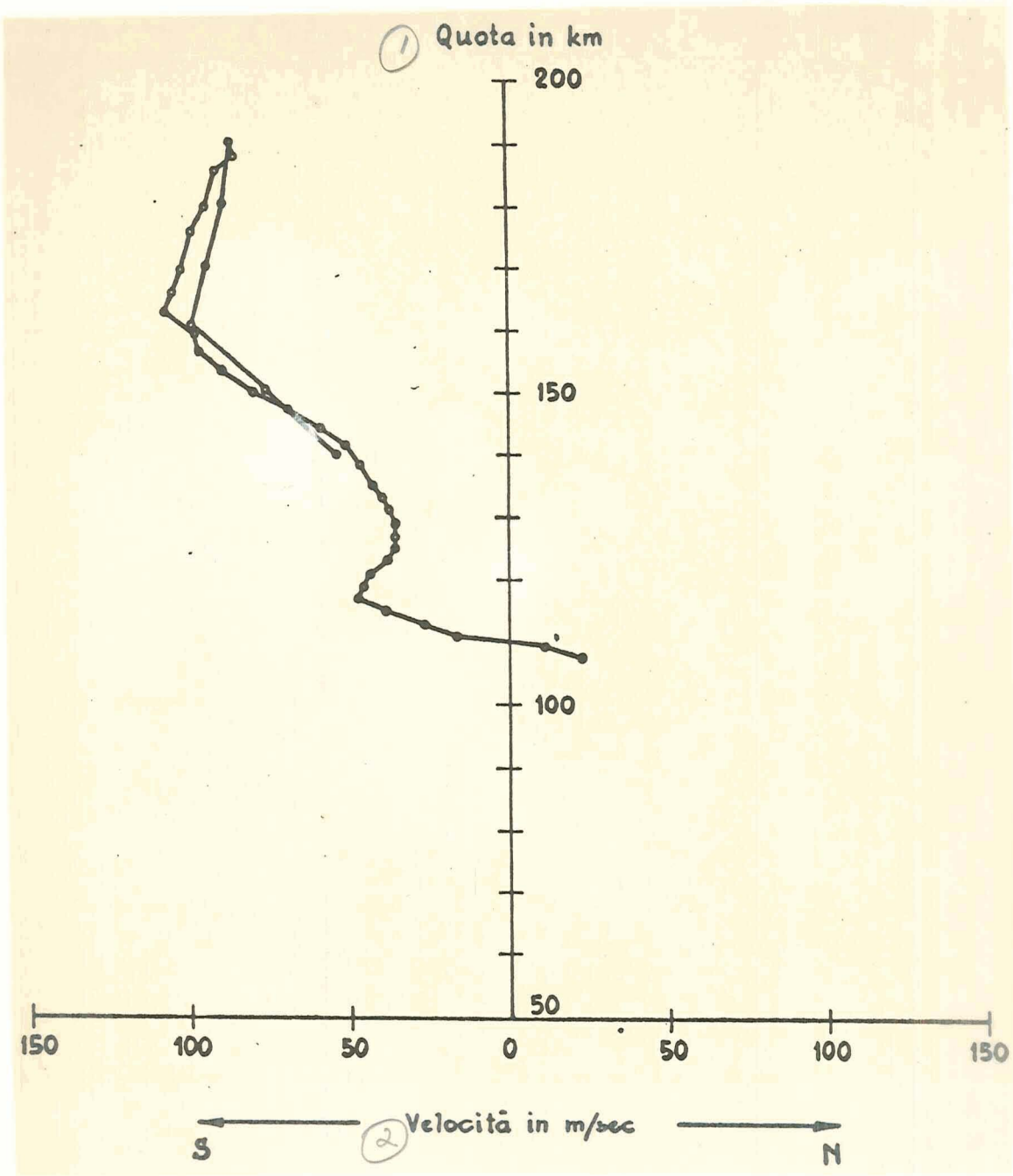

Figure 8. Second Launch, dawn, 20 April 1961. 1 -- alt in km; 2 -- speed in m/sec.

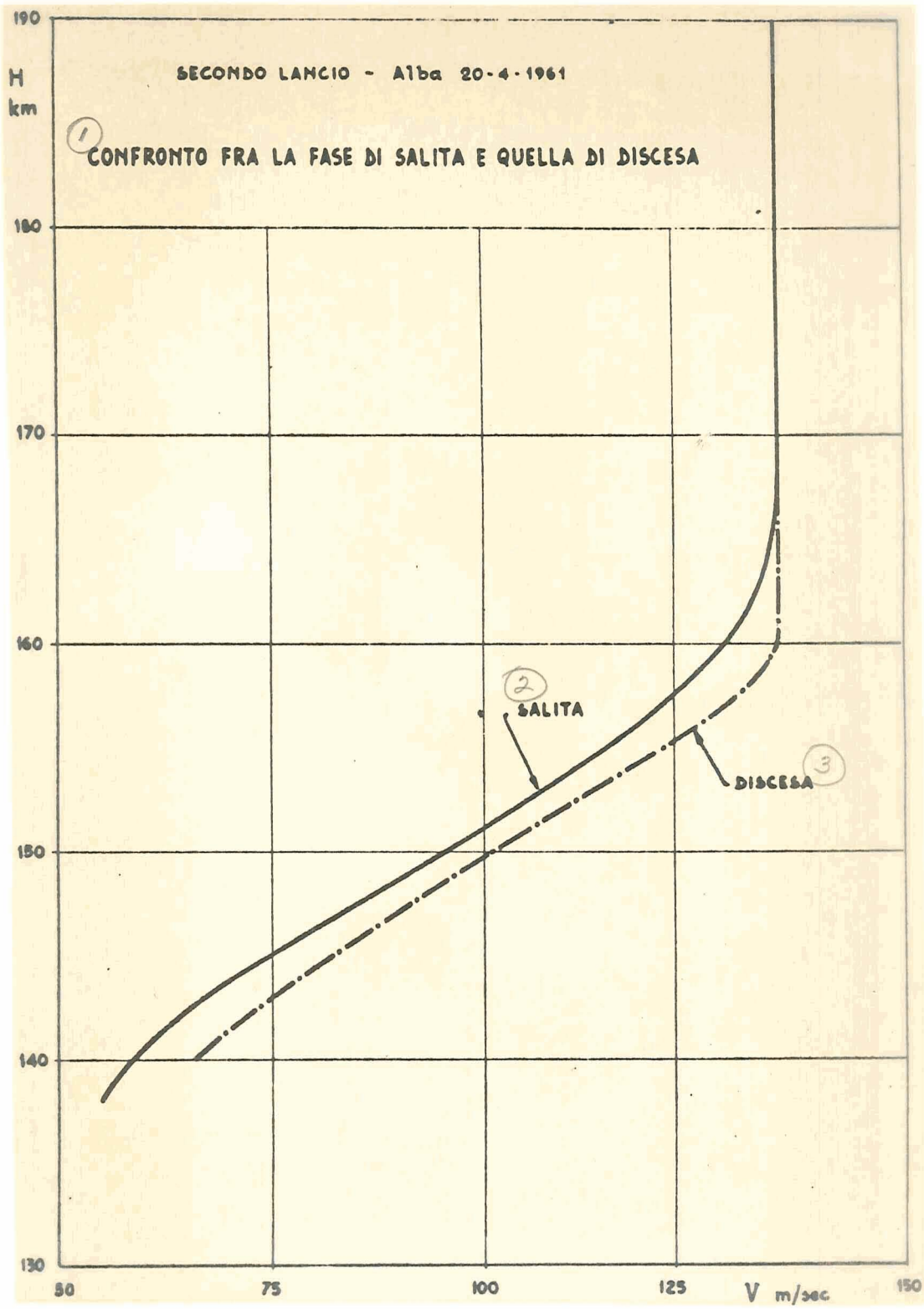

Figure 9. Second Launch, dawn, 20 April 1961. 1 -- comparison between ascent and descent phases; 2 -- ascent; 3 -- descent.

TABLE I

Launching: 19 April 1961, sunset

QUOTA km (1)	VELOCITA' m/sec (2)	DIREZIONE (°) (3)
83	25	0°
85	23	15°
88,5	20	40°
90	20	75°
91,5	26	89°
92,5	28	60°
94	38	307°
95,5	40	336°
96,5	41	33°
98,5	54	42°
101	105	68°
103	106	87°
104,5	115	108°
105	110	138°
106,5	105	147°
108	103	155°
111,5	70	180°
114,5	50	229°
117	55	260°
119	60	274°
122	75	285°
125	72	289°
128	72	280°
130	70	272°
132	60	266°
135	60	260°
138	57	245°
141	62	225°
144	64	212°
147	67	192°
150	70	180°
153	75	180°
156	80	180°
159	85	180°
162	93	180°
165	103	180°
168	112	180°
171	180	180°
174	130	180°
177	135	176°
180	140	170°
183	135	172°
186	130	174°
189	130	178°
200	130	180°

1 -- alt in km; 2 -- speed in m/sec; 3 -- direction (from N in clockwise direction).

TABLE II

Launching: 20 April 1961, dawn

QUOTA km (1)	VELOCITA' m/sec (2)	DIREZIONE (°) (3)
108	27	32°
109,5	29	67°
111	31	123°
113	38	136°
115	45	150°
117	48	180°
119	49	200°
121	49	205°
123	45	213°
125	44	214°
127	44	215°
129	45	216°
131	46	214°
133	48	213°
135	51	212°
138	55	212°
141	61	212°
144	71	213°
147	83	213°
150	96	214°
153	108	214°
156	118	215°
159	121	215°
162	132	215°
165	134	218°
169	135	220°
175	135	222°
179	135	225°
185	135	227°
187	135	230°
190	135	230°
180	135	228°
170	135	225°
160	135	222°
150	101	220°
140	66	215°

1 -- alt in km; 2 -- speed in m/sec; 3 -- direction (from N in clockwise direction).

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